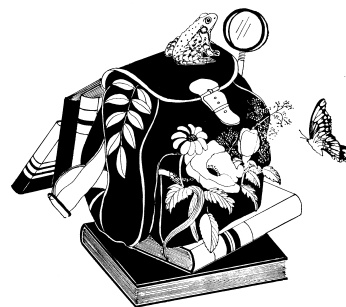


Energy in the Balance

Adapted from The NEED Project



Preparation

Make enough copies of the five Energy Source Rating Sheets so that each group of three students has a complete set. Make one transparency of each rating sheet on which to record a class summary of the group results.

Procedure

Divide your class into groups of three students. Provide one set of rating sheets to each group. For younger students, you may want to complete the first rating sheet with the students as a class.

Explain to the students that they will be working in groups to complete rating sheets about the ten major sources of energy used in the United States. They will complete the rating sheets by reading each statement and deciding as a group if it is:

u *Fact*: If the statement isn't a good or a bad thing about the source, then it's a fact. For Example: We're going on a field trip today.

u *Advantage*: If the statement is a good thing about the energy source, then it's an advantage. For example: We'll have cake and ice cream on the field trip.

u *Disadvantage*: If the statement is a bad thing about the energy source, then it's a disadvantage. For example: The bus for the field trip is late.

Tell the students to disregard the Rating column as they complete the forms. They will complete this column later, after they have read all of the rating sheets.

u *Disagreements*: If the students in the group cannot agree on a statement after a brief discussion, they should note that on the sheet and move on to the next statement.

u *Finish*: Have the groups write their names on the back of the rating sheets, collect them, and explain that the students will work in the same groups the next day.

Have the students return to their groups. Explain that they will begin deciding how important the advantages and disadvantages are by rating them. The groups will complete the rating sheets one at a time, then compile a class average, before moving on to the next rating sheet. Give the students the following explanations:

u *Fact*: If the group decided the statement is a fact, the rating for that statement is a zero. There is no rating (0) to a fact that is neither an advantage nor a disadvantage.

u *Advantage/Disadvantage*: If the group decided that the statement is an advantage or a disadvantage, they must decide the importance of the advantage or disadvantage—its rating.

Grade Levels: 4-6

Science SOLs: 4.8, 5.7, 6.3, 6.5, 6.11, PS.6, ES.7

Materials Needed:

- r Rating sheets, sets of 5
- r Transparencies (5)
- r Pens and markers

Objectives:

This cooperative activity encourages students to evaluate the advantages and disadvantages of the major energy sources through a series of rating activities.

Vocabulary Words:

atom
advantage / disadvantage
biomass
carbon dioxide
coal
electricity
fission / fusion
geothermal energy
greenhouse gas
hydroelectric power
import / export
kinetic
mining
natural gas
nuclear energy
nucleus
petroleum
photovoltaic cell
potential
propane
reclamation
renewable / nonrenewable
reservoir
solar energy
uranium
wind energy

Write the scale below on the chalk board for the students to use as a guide:

Disadvantage	-10	-8	-6	-4	-2	0	+2	+4	+6	+8	+10	Advantage
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Notice that all advantages are positive numbers—they add to the value of the energy source; while all disadvantages are negative numbers—they subtract from the value of the energy source.

Explain that the groups can decide on any number between -10 and +10 as the rating. For example:


- u Our basketball team is playing our big rival on Friday night. (Fact)
- u Our coach has a cold. (Disadvantage -1)
- u Their best player broke his leg yesterday. (Advantage +8)
- u We're playing in their gym. (Disadvantage -4)
- u We've beaten them twice this year. What do you think?

u *Rate the Sources:* Once all of the students understand the rating system, they should begin to rate the first energy source—Biomass. For younger students, you may want to complete the first sheet as a class. Each group should try to reach a consensus on the rating, but if they cannot, they should compromise by calculating the average rating for the group. Emphasize that there are no right or wrong answers in the ratings and that it is all right for different people and groups to place different values on the advantages and disadvantages.

u *Total the Rating:* After the groups have completed each sheet, they should calculate the total rating for the sheet by adding the positive numbers together and subtracting the negative numbers. The total can be a negative number.

Summarize

Using the transparency of the rating sheet and the overhead projector, tally the results of all the groups, statement by statement, as shown in the sample here:

 BIOMASSenergy	FACT	ADVANTAGE	DISADVANTAGE	RATING
Biomass is plants, trees, garbage, waste - anything that was alive a short time ago.	1111			0
Biomass is a renewable energy source. We can grow biomass in a short period of time.		1111		+5 +6 +3 +8
Biomass doesn't have as much energy as fossil fuels. We have to burn more biomass to get the same amount of energy.			1111	-5 -6 -3 -2

u *Disagreements:* If there is disagreement about whether a statement is fact, an advantage or a disadvantage, have one student from each opposing group give the rationale for their decision. The rating scores can also be discussed, if there is a marked disparity in the scores and you wish to expand the unit.

u *Average the Results:* Work with the students to average the rating for each source by adding together all of the scores and dividing by the number of groups. Each group should write the average score next to their group's rating for comparison.


Discussion

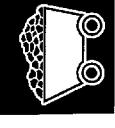
Ask the students if they notice a trend in their group's ratings, compared to the average. For example, are some groups more concerned about environmental impacts than economic impacts?

Finish

Follow the procedure above for the remaining rating sheets.

Energy Source Rating Sheet

 BIOMASS energy		FACT	ADVANTAGE	DISADVANTAGE	RATING
1.	Biomass is plants, trees, garbage, yard waste—anything that was alive a short time ago.				
2.	All biomass contains energy. Biomass absorbs its energy from the sun and stores it as chemical energy.				
3.	Biomass is a renewable energy source. We can grow biomass in a short period of time.				
4.	We can burn biomass to make heat. We can use the heat to make products, heat buildings, and make electricity.				
5.	Biomass doesn't have as much energy as fossil fuels. We have to burn more biomass to get the same amount of energy.				
6.	Burning biomass can pollute the air, but not as much as burning fossil fuels. Biomass can also smell bad when it is burned.				
7.	We can also use biomass to make a fuel called ethanol. It is a cleaner fuel than gasoline, but more expensive to use.				
8.	Biomass can be made into a gas called methane and burned like natural gas to make heat.				
9.	We transport biomass mostly by trucks.				
10.	About three percent of the energy we use in the U.S. is from biomass. Industry makes products with most of the biomass we use.				
TOTAL RATING					

 COAL energy		FACT	ADVANTAGE	DISADVANTAGE	RATING
1.	Coal is shiny black rock that is buried underground.				
2.	Coal contains energy—chemical energy. It was formed long ago from ancient plants. Coal is called a fossil fuel.				
3.	Coal is a nonrenewable energy source. We can't make more in a short period of time.				
4.	We burn coal to make heat. We use the heat to make electricity. Industry also burns coal to make steel and other products.				
5.	We have a lot of coal in the U.S. Burning coal is a cheap way to make electricity. Most of our electricity comes from coal.				
6.	Burning coal can pollute the air. It also produces carbon dioxide—a greenhouse gas.				
7.	Power plants and industry work hard to reduce the amount of air pollution from burning coal.				
8.	We dig coal from huge coal mines. Coal mines can pollute our water if they are not carefully managed.				
9.	We transport coal mostly by trains and, sometimes, by barges and trucks.				
10.	About 23 percent of the energy we use in the U.S. is from coal. We use most of the coal to make electricity.				
TOTAL RATING					

Energy Source Rating Sheet



GEOTHERMAL energy

FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Geo means earth; therme means heat. Geothermal means earth-heat.			
2. The center of the earth is very hot. This heat warms water and rocks near the surface. We can use this heat as energy—thermal energy.			
3. Geothermal energy is renewable energy. Rocks in the center of the earth produce more heat all the time.			
4. Very hot geothermal steam can heat buildings and make electricity. Hot steam reservoirs are found in Western states and in Hawaii.			
5. Geothermal power plants are built on top of steam reservoirs. They are expensive to build, but the fuel is free.			
6. Geothermal steam can contain dangerous chemicals. Power plants clean the steam or put the chemicals back into the earth.			
7. Low temperature geothermal energy is found everywhere in the U.S., just a few feet underground.			
8. Low temperature geothermal energy can be used to heat and cool buildings. The systems are expensive to build, but cheap to run.			
9. Geothermal energy is used where it is found. We don't transport it long distances.			
10. Geothermal energy provides the U.S. with about 0.5 % (one half of one percent) of the energy we use, mostly to heat and cool buildings.			

TOTAL RATING _____




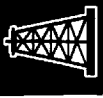
HYDROPOWER energy

FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Hydro means water. Hydropower is the energy of moving water.			
2. Gravity pulls water from high ground to low ground. There is energy in moving water—mechanical energy.			
3. Water is a renewable energy source. Rain will fall as long as the sun shines and evaporates water from the oceans, rivers, and lakes.			
4. Dams can be built across rivers to harness the energy in water. Turbines at the bottom of the dams make electricity.			
5. Hydropower is the cheapest way to make electricity. The fuel, water, is free to use and you don't need to transport it. Gravity moves it.			
6. Hydropower plants do not pollute the air since no fuel is burned.			
7. Hydropower dams can flood a lot of land when they are built. They can also disturb fish and wildlife habitats.			
8. The lakes made by the dams can be used for fishing, boating and other sports. They can also help prevent floods.			
9. Most of the good places to put hydro dams have been used. The U.S. will not build many more hydro dams.			
10. Hydropower provides the U.S. with about four percent of the energy we use.			

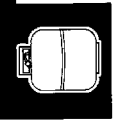
TOTAL RATING _____


Energy Source Rating Sheet

 NATURAL GAS <i>energy</i>		FACT	ADVANTAGE	DISADVANTAGE	RATING
1.	Natural gas has no taste, color, or smell. A smell, like rotten eggs, is added so we can tell if there is a gas leak.				
2.	Natural gas contains energy—chemical energy. It was formed long ago from tiny sea plants and animals. It is a fossil fuel.				
3.	Natural gas is buried underground in pockets of rocks. It is a nonrenewable energy source and took a very long time to form.				
4.	We can burn natural gas to make heat. We can use the heat to make products, warm buildings, and make electricity.				
5.	We have a 35-year supply of natural gas at the price we pay today. There is plenty more in the U.S. if we want to pay more to get it.				
6.	Natural gas is a clean-burning fossil fuel, but burning it does produce some air pollution and carbon dioxide—a greenhouse gas.				
7.	Cars with special engines can run on natural gas. Natural gas is cleaner than gasoline, but more expensive to use.				
8.	We dig wells deep into the ground to get natural gas. It is sent to a plant to be cleaned after it is pumped out of the ground.				
9.	We transport natural gas across the country through pipelines. There are more than a million miles of pipelines in the U.S.				
10.	About 23 percent of the energy we use in the U.S. comes from natural gas. Mostly, we use natural gas to make products and heat our homes.				
TOTAL RATING					


 PETROLEUM <i>energy</i>		FACT	ADVANTAGE	DISADVANTAGE	RATING
1.	Petroleum is oil that is buried underground in pockets of rock. We drill wells into the ground and under the oceans to reach it.				
2.	Petroleum contains lots of energy—chemical energy. It was formed long ago from tiny sea plants and animals. Petroleum is a fossil fuel.				
3.	Petroleum is a nonrenewable energy source. We can't make more petroleum in a short period of time.				
4.	We can burn petroleum for energy. We use petroleum mostly for transportation fuels. It can also heat buildings and make electricity.				
5.	Petroleum is also used to make plastics, medicines, paint, soaps, and many other products.				
6.	Burning petroleum can pollute the air. Burning it also produces carbon dioxide—a greenhouse gas.				
7.	Drilling for oil and transporting it can harm the land and water if the oil spills. Oil companies work hard to keep oil from spilling.				
8.	We don't drill enough petroleum to meet our needs. We buy about half of the petroleum we use from other countries.				
9.	We transport petroleum by pipelines, oil tankers and trucks.				
10.	About 37 percent of the energy we use in the U.S. comes from petroleum. We use more petroleum than any other energy source.				
TOTAL RATING					


Energy Source Rating Sheet

 PROPANE energy	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Propane is a gas with no color, taste, or smell. It is buried underground with petroleum and natural gas.				
2. Propane contains energy—chemical energy. It was formed long ago from tiny sea plants and animals. Propane is a fossil fuel.				
3. Propane is a nonrenewable energy source. We can't make more propane in a short period of time.				
4. We can burn propane for energy. We use propane to heat buildings in rural areas. We also use it in grills and as a clean fuel for vehicles.				
5. Propane turns into a liquid under pressure. It takes up less space as a liquid. A one-gallon tank can hold 270 gallons of propane gas.				
6. Propane is a portable fuel. As a liquid, trucks can carry propane to rural areas that don't have natural gas pipelines.				
7. Propane is a cheap and clean-burning fuel. We use propane to fuel vehicles that we operate inside buildings—like forklifts.				
8. Propane produces some air pollution and carbon dioxide when it is burned.				
9. We transport propane by pipelines and trucks. We store propane in tanks under pressure—as a liquid.				
10. One and a half (1.5%) percent of the energy we use comes from propane. We use propane mostly in rural areas to heat buildings.				
TOTAL RATING				

 SOLAR energy	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Sol means sun. Solar energy is energy from the sun.				
2. The sun is a big ball of gas. It produces energy all the time. The sun's energy reaches the earth in rays—radiant energy.				
3. Solar energy is a renewable energy source. We will have solar energy as long as the sun shines.				
4. We get light from the sun every day. We can also capture the sun's energy to heat water and buildings and to make electricity.				
5. Photovoltaic (PV) cells can change solar energy directly into electricity. PV cells are used in places with no power lines.				
6. Electricity from PV cells is more expensive than from power plants.				
7. Solar energy is free to use. It is also a clean energy source—no fuel is burned to make the heat or electricity.				
8. The sun's energy is spread out and hard to capture. The energy is only available when the sun is shining, not 24 hours a day.				
9. We don't transport solar energy. We use it where we find it.				
10. Solar energy provides the U.S. with 0.5 % (one-half of a percent) of the energy we use, not counting the light we use every day.				
TOTAL RATING				

Energy Source Rating Sheet

 URANIUM (nuclear) energy	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Everything in the universe is made of tiny particles called atoms. In the center of every atom is a nucleus, with even smaller particles.				
2. The nucleus has energy that holds it together—nuclear energy. The nucleus of a uranium atom has lots of energy holding it together.				
3. Uranium is a mineral buried underground. It is a nonrenewable energy source—we can't make more uranium.				
4. We have a lot of uranium in the U.S. It is a cheap energy source.				
5. We can split atoms of uranium into two smaller atoms. When we split atoms of uranium, some of the nuclear energy is set free as heat.				
6. We can use this heat to make electricity. The uranium isn't burned, so there is no air pollution.				
7. When we split uranium, rays of energy—called radiation—are also produced. This radiation can be very dangerous.				
8. The waste from nuclear plants produces radiation for a long time. Many people are concerned about how to store this waste.				
9. We transport uranium mostly by truck.				
10. About seven percent (7 %) of the energy we use in the U.S. comes from uranium. It is used to make electricity.				
TOTAL RATING				

 WIND energy	FACT	ADVANTAGE	DISADVANTAGE	RATING
1. Wind is moving air—air in motion—mechanical energy.				
2. The sun heats the earth unevenly. The warm air rises and cool air rushes in—that's wind.				
3. Wind energy is a renewable energy source. We will have wind as long as the sun shines.				
4. Windmills can capture the energy in wind to make electricity. Many windmills together are called a wind farm.				
5. Windmills take up a lot of land, but the land can also be used for farming or grazing animals.				
6. Wind energy is free to use. It is also a clean energy source—no fuel is burned to make electricity.				
7. Electricity from new windmills is almost as cheap as electricity from coal power plants.				
8. Many places don't have enough wind to make electricity, and the wind doesn't blow all the time.				
9. We don't transport wind energy. We use it where we find it.				
10. Wind energy provides the U.S. with 0.5 % (one-half of a percent) of the energy we use.				
TOTAL RATING				



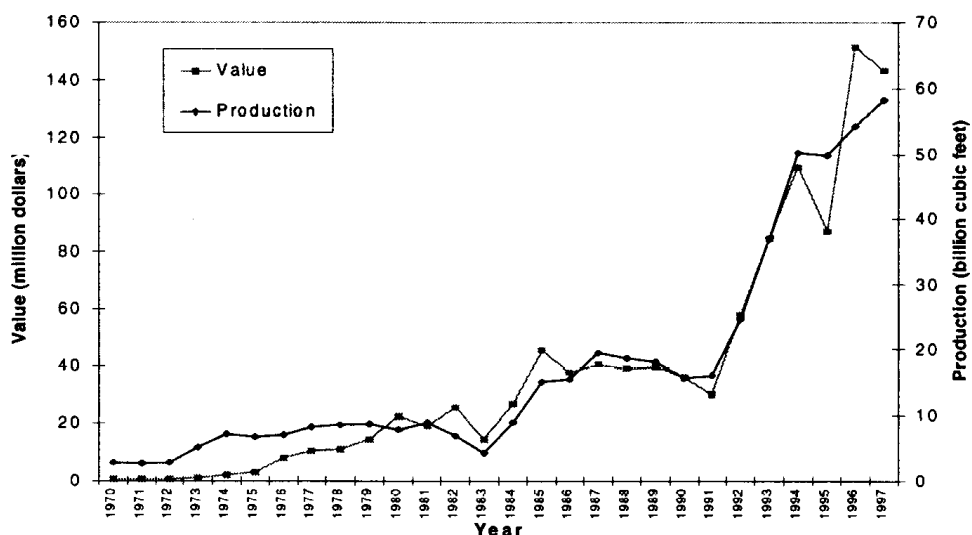
Coal Mine Production (Short Tons) in Virginia by County and Mining Method, 1997

	Buchanan	Dickenson	Lee	Russell	Scott	Tazewell	Wise	Total
Number of Mines								
Auger	9	6	4	1	0	0	11	31
Strip	11	13	4	5	0	0	28	61
Surface Total	20	19	8	6	0	0	39	92
Undg. total	123	24	15	9	0	35	58	264
Total	143	43	23	15	0	35	97	356
Tonnages								
Auger	23,615	46,270	34,007	4,199	0	0	297,608	405,698
Strip	974,615	1,206,756	217,442	237,421	0	0	5,858,587	8,494,642
Surface Total	998,230	1,253,026	251,449	241,440	0	0	6,156,195	8,900,340
Undg. total	12,976,600	2,107,139	1,297,364	767,590	0	2,285,455	8,554,679	27,988,826
Total	13,974,830	3,360,165	1,548,813	1,009,030	0	2,285,455	14,710,874	36,889,166
Mining Method (tonnage)								
Underground								
Longwall	7,884,760	0	0	0	0	0	0	7,884,760
Continuous miner	5,083,122	2,044,045	1,297,364	767,590	0	2,284,614	8,535,817	20,012,552
Other	8,718	63,094	0	0	0	841	18,861	91,514
Undg. total	12,976,600	2,107,139	1,297,364	767,590	0	2,285,455	8,554,678	27,988,826
Surface								
Auger	23,615	46,270	34,007	4,199	0	0	297,608	405,698
Strip	974,615	1,206,756	217,442	237,241	0	0	5,858,587	8,494,642
Surface total	998,230	1,253,026	251,449	241,440	0	0	6,156,195	8,900,340
Total	13,974,831	360,165	1,548,813	1,009,029	0	2,285,455	14,710,874	36,889,166

Source: Virginia Division of Mines.

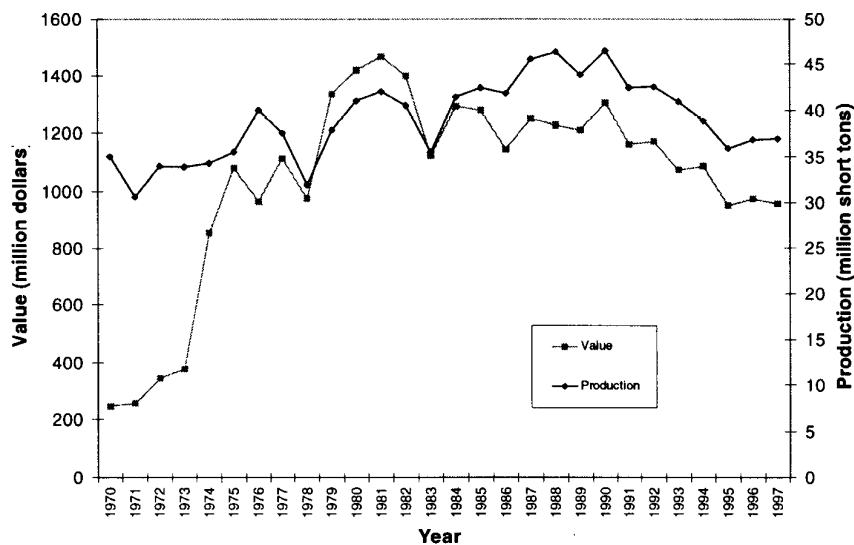


Trend in Natural Gas Production and Value, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.

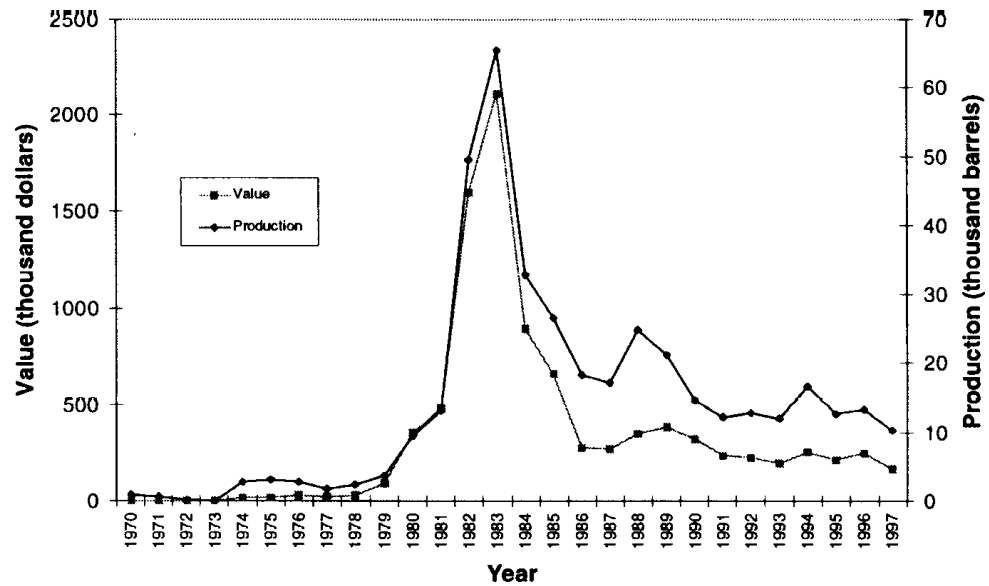
Trend in Coal Production and Value, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.

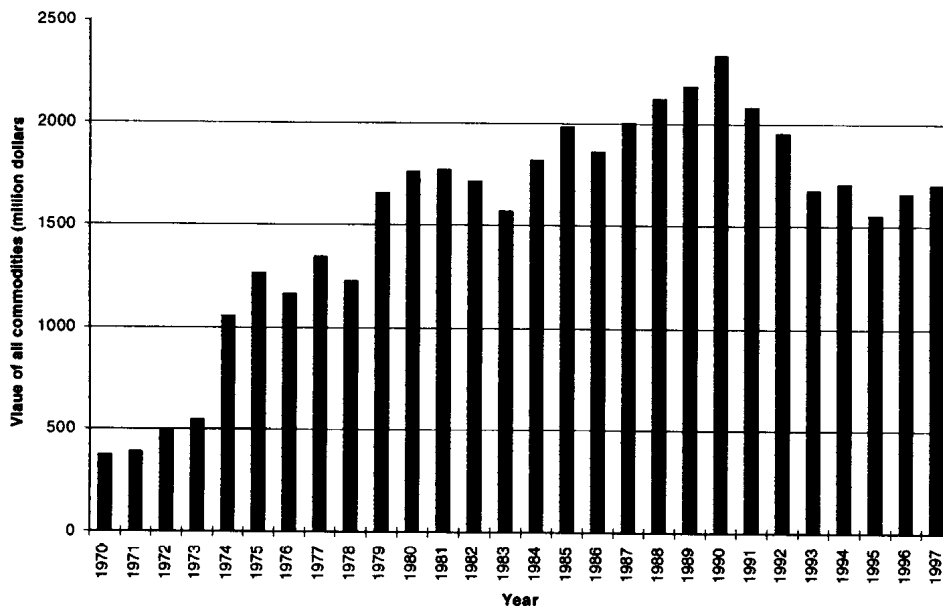


Trend in Oil Production and Value, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.

Total Value of Mineral Production in Virginia, 1970-1997



Source: Va. Department of Mines, Minerals and Energy, 1998.